Introduction

Mosquitoes cause health problems by their bites and by disease transmission. Millions of cases of disease are caused worldwide each year by mosquitoes. Repellents, bed nets and other personal protection measures can help prevent mosquito-carried diseases. However, insect repellents are not entirely safe – especially if misused. This brochure is intended to help consumers choose and properly use repellents.

DEET Products

N,N-diethyl-3-methylbenzamide (DEET) is probably the best insect repellent. The chemical was discovered by USDA scientists and patented by the U.S. Army in 1946. It was registered for use by the public in 1957.

Twenty years of testing of more than 20,000 chemical compounds has not resulted in another product with the duration of protection and effectiveness of DEET. The repellent is sold under numerous brand names (Off®, Cutter®, etc.) and is formulated in various ways and concentrations – creams, lotions, sprays, extended-release formulations, etc.

Concentrations of DEET range from about five percent to 100 percent and, generally, products with higher concentrations of DEET repel insects longer. However, at some point there is not a direct correlation between concentration and repellency.

For example, 50 percent DEET provides about four hours of protection against mosquitoes, but increasing the concentration to 100 percent provides only one additional hour of protection.

Picaridin

Picaridin, also known as Bayrepel® or KBR 3023, is an effective alternative to DEET products which provides long-lasting protection against mosquito bites. This relatively new repellent has been used worldwide since 1998. As opposed to DEET, Picaridin is nearly odorless, does not cause skin irritation, and has no adverse effect on plastics. However, even though the product is long-lasting and effective against mosquitoes, in some cases research has shown that it does not provide protection as long as DEET. One field study demonstrated five hours of protection against *Culex annulirostris* mosquitoes with Picaridin versus seven hours of protection with DEET products.

Plant-based Repellents

Plant-derived substances that repel mosquitoes include citronella, cedar, verbena, pennyroyal, geranium, lavender, pine, cajuput, cinnamon, rosemary, basil, thyme, allspice, garlic, and peppermint. However, these products generally only provide temporary protection, if any at all. One scientific study using Buzz Away® (containing citronella, cedarwood, eucalyptus, lemongrass alcohol and water) and Green Ban® (containing citronella, cajuput, lavender, safrole-free sassafras, peppermint, bergaptene-free bergamot, calendula, soy, and tea tree oils) showed essentially no repellency against mosquitoes. However, other studies with Buzz Away® indicated that the product does have repellency for about two hours.

One plant-based repellent that was released in the United States in 1997, Bite Blocker® (containing soybean oil, geranium oil and coconut oil) has shown good repellency against *Aedes* mosquitoes for up to 3.5 hours.

Some people use citronella candles as backyard mosquito repellents. One research study compared the ability of commercially available three percent citronella candles, five percent citronella incense and plain candles to prevent bites by *Aedes* mosquitoes. Persons near the citronella candles had 42 percent fewer bites than controls, but even ordinary candles provided a 23 percent reduction. There was no difference between plain candles and citronella incense in repelling mosquitoes.

Permethrin

Permethrin, actually a pesticide rather than a repellent, is a human-made synthetic pyrethroid available for use against mosquitoes, but can ONLY be used on clothing.

The product is sold in lawn, garden, or sporting goods stores as an aerosol under the name Repel Permanone®. It can maintain its potency for at least two weeks, even through several launderings. Permethrin can be applied to clothing, tent walls, and mosquito nets. In fact, sleeping under permethrin-sprayed mosquito nets has been used extensively in malaria prevention campaigns in Africa. The combination of permethrin-treated clothing and DEET-treated skin creates almost complete protection against mosquito bites. In field trials conducted in Alaska, persons wearing permethrin-treated clothing and 35 percent DEET (on exposed skin) had more than 99.9 percent protection.

Skin-So-Soft®

The bath oil Avon Skin-So-Soft® is often used as a mosquito repellent and is discussed here because of its widespread use. Apparently, Skin-So-Soft® does have some transient repellency for mosquitoes, but not much. Skin-So-Soft® is not nearly as effective as DEET (gram for gram).

In a research study, the Avon product provided about one-half hour of protection from mosquito bites compared to more than 10 hours of protection provided by 35 percent DEET. Avon now markets products under the Skin-So-Soft® label that contain an EPA-recognized repellent.

Health Concerns Associated With DEET Products

Background

DEET has been used for more than 30 years by millions of people worldwide. Although it has an excellent safety record, there have been some reports of adverse reactions associated with its use. Most of these have been from accidental exposure, such as swallowing or spraying into the eye.

While most complaints have involved minor skin or eye irritation, rare cases of severe reactions have been reported, especially in children, after ingestion or repeated, prolonged skin application. Adverse reactions have included headache, nausea, behavioral changes, disorientation, loss of muscle coordination, irritability, confusion, difficulty sleeping, and even convulsions and death.

In one report, six girls ranging in age from 17 months to eight years developed behavioral changes, seizures, or coma after repeated skin exposure to DEET; three later died. However, if DEET products (preferably not the high concentration products such as 75-100 percent) are properly applied and used according to their label directions, they are considered safe. Use of DEET products according to EPA guidelines (next column) will greatly reduce the possibility of toxicity.

Safe Application Methods

Except under unusual conditions, high concentrations of DEET should not be used. Products with 10-35 percent DEET will provide adequate protection under most conditions. The American Academy of Pediatrics recommends that repellents used on children contain no more than 10 percent DEET. The following guidelines will help ensure safe use of DEET-based repellents. Remember that repellents should only be applied to clothing or exposed skin *according to the product label directions.*

Do

- ✓ Use aerosols or pump sprays for treating skin and clothing. These products provide an even application.
- ✓ Use liquids, creams, lotions or sticks to apply more precisely to exposed skin.
- ✓ Wash DEET-covered skin with soap and water after outdoor activity.
- ✓ Always keep insect repellents out of the reach of small children.

Don't

- ✗ Apply to eyes, lips or mouth, or over cuts, wounds or irritated skin.
- ✗ Over-apply or saturate skin or clothing.
- ✗ Apply to skin under clothing.
- ✗ Apply more often than directed on the product label.

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Mosquito Repellents

Practical Suggestions for Safe Repellent Use